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ABSTRACT

This study describes the evaluation of a model science teacher education program developed with support from the National Science Foundation from 1970 to 1980. This program, named the Undergraduate Preservice Science Teacher Education Program (UPSTEP) was designed to develop science teachers who have a research-based rationale for teaching science. This study was undertaken to follow up on graduates of UPSTEP as inservice teachers and investigate their attitudes, methodologies, goals, and classroom teaching, and to compare these data to a study of participants in the Iowa Honors Workshop using the 1985 version of the National Survey of Science and Mathematics Education. Results are reported on the status of 104 UPSTEP graduates, including the course objectives, teaching techniques, and the perceptions of their students (for those who held teaching jobs). Details are supplied on 12 tables. (CW)

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# An Evaluation of the University of Iowa's Science Teacher Education Program

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Paper Presented at the annual meeting of the National Association for Research in Science Teaching

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## Introduction

From 1970 through 1975 the National Science Foundation provided funds to the University of Iowa Science Education Center to develop a model Secondary Science Teacher Preparation program. This program, named the Undergraduate Preservice Science Teacher Education Program (UPSTEP), was extended from 1975 to 1980 by a secondary grant from the National Science Foundation to produce instructional modules for preservice as well as inservice settings. Most of these materials have been field tested at other institutions involved with science teacher education.

The model of science teacher education at the University of Iowa is basically complete, but evolves to keep pace with the demands of 1986 and beyond. Iowa-UPSTEP revolves around a series of varied, field-based, clinical experiences providing a means to combine the skills and perspective of the university with the realism of the public schools (Lunetta, 1975). This program offers students relevant science education experiences throughout their undergraduate years. These experiences deal with realities of science teaching early in the undergraduate program. Such experiences help UPSTEP students to make early commitments to science education.

The ultimate goal of UPSTEP is to develop science teachers who have a research-based rationale for teaching

science and the ability to apply that rationale in a classroom. The rationale should consist of the conceptualization and integration of all of the following:

1. teacher, student and societal goals for science education;
2. why science should be taught
3. what science must be learned;
4. the nature of science;
5. how to facilitate learning in science in a manner consistent with what is known about adolescents, learning and science;
6. the nature of adolescents; and
7. how to personally assess, evaluate, and change classroom climates and strategies to achieve progress toward stated goals.

Three intensive methods seminars prior to student teaching each focus on relevant skills, experiences, and ideas necessary for exemplary teaching. Each course has related in-school experiences as an integral part of the seminar. Much time is spent on studying research related to effective teaching, planning, and developing strategies consistent with this research.

Yager (1980), in his final report to NSF regarding the UPSTEP program, stressed the importance of studying graduates of this program as inservice teachers in

comparison with other teachers. According to Yager, such a study could provide "the needed information for establishing the strengths and weaknesses of the model based on evidence and direct observation rather than upon faith which has characterized the situation in the past when such evaluation was not conducted". One aspect of this study will allow for the comparison of teaching strategies and methodologies of teachers coming from an innovative program like Iowa's with the teaching strategies and methodologies of teachers from exemplary programs. Another aspect of this study explores the attitudes the science students of UPSTEP graduates have toward science, science teaching, science teachers, and the ability of science to help solve societal problems.

Some evaluation of the program has been done but it has been inadequate. A major reason for this deficiency has been lack of data for comparison. However, a study conducted at the University of Iowa Science Education Center with participants from the Honors workshop using the 1985 version of the National Survey of Science and Mathematics Education (NSSME), now provides sufficient data for comparison with former graduates of UPSTEP. A comparison of the data collected from the Honors workshop participants and the UPSTEP graduates will help to show if the classroom activities and methodologies of UPSTEP graduates differ from those of the Honors workshop participants.

## Research Question

The specific questions to be resolved in this study include:

1. What attitudes do the students of UPSTEP graduates have toward science, science teaching, science teachers?
2. What are the methodologies and classroom activities used by graduates of the UPSTEP programs?
3. How do the methodologies and classroom activities used by graduates of the UPSTEP program compare to participants of the Honors Workshop?
4. What objectives do UPSTEP graduates have for their science teaching?
5. How do the objectives UPSTEP graduates have for their science teaching compare to the objectives Honors workshop participants have for their science teaching?
6. How do UPSTEP graduates use their class time?
7. How does the use of class time for various activities by UPSTEP graduates compare to the use of class time by Honors workshop participants?
8. How does the percent of the textbook covered by UPSTEP graduates compare to the percent of the textbook covered by the Honors workshop participants?

To determine one aspect of the effectiveness of the graduates from the Iowa UPSTEP program since fall, 1976 a 50 item, modified version of the Preferences and Understanding questionnaire (PUQ) developed by Yager and Bonnstetter (1982) was constructed.

The instrument consists of 50 items dealing with the following affective categories:

1. views of science teachers, items 8-15;
2. views of science teaching, items 16-22 and 34-44;
3. views concerning the usefulness of science study, items 23-25;
4. views of what it would be like to be a scientist, items 26-31; and
5. views on solving societal problems, items 45 - 50.

The 41 UPSTEP graduates responding yes to the initial inquiry letter were mailed the modified version of the PUQ. Thirty-seven graduates returned completed questionnaires from their students, providing attitudinal data from 2761 science students. A 90% return rate on the PUQ was obtained. No follow-up was conducted on the three graduates who did not return the questionnaires, since answer sheets were returned during the summer.

The UPSTEP graduates were instructed not to administer the questionnaires until the last week of class. Student attitude data was collected at the end of the semester so

their most recent science teacher, from UPSTEP, would be highly influential. Data analysis was conducted with the teacher as the unit of analysis.

In September, 1985 forty of the UPSTEP graduates were sent out the 1985 version of the National Survey of Science and Mathematics Education (NSSME).

The 1985 National Survey of Science and Mathematics Education asked teachers for the following information:

6. factors influencing teaching a difficult topic;
7. factors affecting science instruction;
8. qualification for teaching assigned courses;
9. amount of class time spent on daily routines, interruptions, getting students to behave, and instruction or student practice;
10. objectives for a specified course;
11. use of various teaching strategies;
12. use of various equipment and materials in teaching;
13. use of textbook including percent of textbook covered.

## Results

### Summary of UPSTEP Graduates

The following summary describes the current status of the UPSTEP graduates:

1. One hundred and four students graduated from the UPSTEP program between the fall semester 1977 and the spring semester 1985;
2. Forty-four UPSTEP graduates taught science in the U.S. during the 1984-1985 shool year;
3. Four additional graduates who did not teach in 1984-1985 taught during the 1985-1986 school year;
4. Four graduates were teaching overseas during the 84-85 school year;
5. One graduate was teaching only mathematics;
6. Three graduate were teaching in post-secondary institutions;
7. Thirteen graduates never taught and never plan to teach;
8. Five graduates did teach but never plan to teach again;
9. Four graduates did teach and plan to teach again;
10. Three graduates never taught, but plan to teach in the future;
11. Six others were not teaching during the 84-85 school year, but further information on these graduates could not be obtained; and
12. No information was obtained on 16 of the UPSTEP graduates.

Table 1

Objectives for Course--
Physical Science Grades 7, 8
and 9

| | MEAN | | SD | | RANGE | |
|---|---|---|---|---|---|---|
| | HWP | UPSTEP | HWP | UPSTEP | HWP | UPSTEP |
| Become interested in science | 4.0 | 3.9 | 1.04 | 0.38 | 1-5 | 3-4 |
| Know scientific facts and principles | 3.6 | 3.3 | 0.77 | 0.95 | 2-5 | 2-5 |
| Develop an attitude of inquiry | 4.3 | 4.1 | 0.96 | 0.38 | 1-5 | 4-5 |
| Develop an awareness of the importance of science in everyday life | 4.2 | 4.0 | 0.90 | 0.82 | 1-5 | 3-5 |
| Perform computations with speed and accuracy | 2.4 | 2.6 | 1.01 | 0.98 | 1-5 | 1-4 |
| Develop an awareness of the importance of science in technology | 3.7 | 3.4 | 0.89 | 0.79 | 2-5 | 3-5 |
| Develop a systematic approach to solving problems | 3.9 | 3.9 | 0.79 | 0.69 | 2-5 | 3-5 |
| Learn about the career relevance of science | 3.0 | 2.6 | 1.09 | 1.13 | 1-5 | 1-4 |

HWP N = 40
UPSTEP N = 7

Table 2

Objectives for Course--Physical Science Grades 10, 11 and 12

| | MEAN | | SD | | RANGE | |
|---|---|---|---|---|---|---|
| | HWP | UPSTEP | HWP | UPSTEP | HWP | UPSTEP |
| Become interested in science | 3.8 | 4.4 | 1.07 | 0.69 | 1-5 | 3-5 |
| Know scientific facts and principles | 4.3 | 3.4 | 0.99 | 1.26 | 2-5 | 1-5 |
| Develop an attitude of inquiry | 4.4 | 4.2 | 0.77 | 0.62 | 3-5 | 3-5 |
| Develop an awareness of the importance of science in everyday life | 3.9 | 3.9 | 1.03 | 0.88 | 1-5 | 3-5 |
| Perform computations with speed and accuracy | 2.8 | 2.3 | 1.34 | 1.34 | 1-5 | 0-4 |
| Develop an awareness of the importance of science in technology | 3.6 | 3.2 | 1.12 | 1.34 | 1-5 | 1-5 |
| Develop a systematic approach to solving problems | 4.2 | 4.8 | 1.02 | 0.42 | 1-5 | 4-5 |
| Learn about the career relevance of science | 3.0 | 2.4 | 1.03 | 1.43 | 1-5 | 0-4 |

HWP N = 19
UPSTEP N = 10

Table 3

Objectives for Course--
Biological Science Grades 10, 11
and 12

| | MEAN | | SD | | RANGE | |
|---|---|---|---|---|---|---|
| | HWP | UPSTEP | HWP | UPSTEP | HWP | UPSTEP |
| Become interested in science | 3.8 | 3.7 | 0.87 | 0.67 | 2-5 | 3-5 |
| Know scientific facts and principles | 4.2 | 3.3 | 0.66 | 0.86 | 3-5 | 2-5 |
| Develop an attitude of inquiry | 3.8 | 4.2 | 0.89 | 0.83 | 2-5 | 3-5 |
| Develop an awareness of the importance of science in everyday life | 4.4 | 4.2 | 0.63 | 0.67 | 2-5 | 3-5 |
| Perform computations with speed and accuracy | 2.4 | 1.9 | 1.09 | 0.93 | 1-4 | 1-3 |
| Develop an awareness of the importance of science in technology | 3.3 | 3.7 | 1.25 | 0.67 | 1-5 | 2-5 |
| Develop a systematic approach to solving problems | 3.7 | 4.1 | 1.01 | 0.61 | 1-5 | 3-5 |
| Learn about the career relevance of science | 3.2 | 3.1 | 1.32 | 0.60 | 1-5 | 2-4 |

HWP N = 19
UPSTEP N = 9

Table 4

Use of Various Teaching Techniques--
Physical Science Grades 7, 8 and 9

| | MEAN | | SD | | RANGE | |
|---|---|---|---|---|---|---|
| | HWP | UPSTEP | HWP | UPSTEP | HWP | UPSTEP |
| Lectures | 4.0 | 4.0 | 0.85 | 0.57 | 2-5 | 3-5 |
| Discussion | 4.6 | 4.4 | 0.68 | 0.53 | 2-5 | 4-5 |
| Student report/ projects | 2.6 | 3.0 | 0.62 | 1.00 | 2-4 | 1-4 |
| Library work | 2.1 | 2.0 | 0.56 | 0.86 | 1-3 | 1-3 |
| Students work at board | 1.8 | 2.3 | 0.79 | 0.49 | 2-4 | |
| Students usings computers | 1.7 | 2.4 | 0.88 | 1.40 | 1-4 | 1-5 |
| Students using calculators | 2.2 | 3.1 | 1.1 | 0.90 | 1-4 | 2-4 |
| Students usings hands-on, manipulative materials | 4.1 | 4.3 | 0.59 | 0.49 | 3-5 | 4-5 |
| Students doing seatwork assigned from the textbook | 3.3 | 3.6 | 1.18 | 1.13 | 1-5 | 2-5 |
| Students completing supplemental worksheets | 3.5 | 3.9 | 1.09 | 0.38 | 1-5 | 3-4 |
| Students working in teacher-led small groups | 2.8 | 2.3 | 1.15 | 1.03 | 1-5 | 1-3 |
| Students working in peer-led small groups | 3.2 | 3.3 | 1.26 | 1.11 | 1-5 | 1-4 |
| Student-to-student tutoring | 2.6 | 2.9 | 1.29 | 0.38 | 1-5 | 2-3 |
| Field trips, excursions | 1.7 | 1.9 | 0.60 | 0.69 | 1-3 | 1-3 |

Table &refname1 (cont.)

| | | | | | | |
|---|---|---|---|---|---|---|
| Guest speakers..... | 1.9 | 1.9 | 0-54 | 0.39 | 1-4 | 1-2 |
| Teacher demonstration..... | 3.5 | 3.7 | 0.72 | 0.76 | 2-5 | 3-5 |
| Tests or quizzes..... | 3.4 | 3.6 | 0.50 | 0.54 | 3-4 | 3-4 |
| Homework assignments..... | 4.3 | 4.4 | 0.69 | 0.54 | 2-5 | 4-5 |

HWP N = 40
UPSTEP N = 7

Table 5

Use of Various Teaching Techniques--
Physical Science Grades 10, 11 and
12

| | MEAN | | SD | | RANGE | |
|---|---|---|---|---|---|---|
| | HWP | UPSTEP | HWP | UPSTEP | HWP | UPSTEP |
| Lectures | 4.0 | 3.6 | 1.05 | 0.84 | 1-5 | 2-5 |
| Discussion | 4.5 | 4.0 | 0.96 | 1.05 | 1-5 | 2-5 |
| Student report/ projects | 2.6 | 2.8 | 0.96 | 0.83 | 1-4 | 2-4 |
| Library work | 1.8 | 2.2 | 1.02 | 0.63 | 1-4 | 1-3 |
| Students work at board | 2.9 | 2.2 | 1.08 | 0.63 | 1-5 | 1-3 |
| Students usings computers | 2.9 | 2.2 | 1.05 | 0.63 | 1-4 | 1-3 |
| Students using calculators | 4.7 | 3.8 | 0.45 | 1.40 | 4-5 | 1-6 |
| Students usings hands-on, manipulative materials | 4.2 | 4.6 | 0.43 | 0.52 | 4-5 | 4-5 |
| Students doing seatwork assigned from the textbook | 3.1 | 3.8 | 1.40 | 1.03 | 1-5 | 2-5 |
| Students completing supplemental worksheets | 2.9 | 3.9 | 1.20 | 1.10 | 1-5 | 2-5 |
| Students working in teacher-led small groups | 3.1 | 3.1 | 1.10 | 1.52 | 1-5 | 1-5 |
| Students working in peer-led small groups | 3.1 | 3.8 | 1.10 | 1.14 | 1-5 | 1-5 |
| Student-to-student tutoring | 3.2 | 4.1 | 1.17 | 1.20 | 1-5 | 2-5 |
| Field trips, excursions | 1.7 | 1.8 | 0.95 | 0.42 | 1-5 | 1-2 |

Table &refname1 (cont.)

| | | | | | | |
|---|---|---|---|---|---|---|
| Guest speakers..... | 1.7 | 1.6 | 0.48 | 0.52 | 1-2 | 1-2 |
| Teacher demonstration..... | 3.6 | 3.5 | 1.11 | 0.85 | 1-5 | 2-5 |
| Tests or quizzes..... | 3.0 | 3.4 | 0.62 | 0.52 | 1-4 | 3-4 |
| Homework assignments..... | 4.5 | 4.7 | 1.02 | 0.48 | 1-5 | 4-5 |

HWP N = 19
UPSTEP N = 10

Table 6

Use of Various Teaching Techniques--
Biological Science Grades 10, 11 and
12

| | MEAN | | SD | | RANGE | |
|---|---|---|---|---|---|---|
| | HWP | UPSTEP | HWP | UPSTEP | HWP | UPSTEP |
| Lectures | 4.1 | 3.9 | 0.62 | 0.60 | 3-5 | 3-5 |
| Discussion | 4.3 | 4.1 | 0.95 | 1.23 | 2-5 | 1-5 |
| Student report/ projects | 2.8 | 2.6 | 1.00 | 0.73 | 2-5 | 2-4 |
| Library work | 2.2 | 2.3 | 0.68 | 0.50 | 1-4 | 2-3 |
| Students work at board | 1.9 | 1.9 | 1.09 | 1.05 | 1-5 | 1-4 |
| Students usings computers | 1.9 | 2.0 | 1.29 | 0.71 | 1-5 | 1-3 |
| Students using calculators | 1.9 | 1.9 | 1.29 | 0.76 | 1-5 | 1-3 |
| Students usings hands-on, manipulative materials | 4.2 | 4.4 | 0.45 | 0.53 | 4-5 | 4-5 |
| Students doing seatwork assigned from the textbook | 2.9 | 3.7 | 1.60 | 1.12 | 1-5 | 2-5 |
| Students completing supplemental worksheets | 3.0 | 3.6 | 1.32 | 1.13 | 1-5 | 1-5 |
| Students working in teacher-led small groups | 3.3 | 2.7 | 1.08 | 1.00 | 1-5 | 1-4 |
| Students working in peer-led small groups | 3.1 | 2.9 | 1.02 | 1.05 | 2-5 | 1-4 |
| Student-to-student tutoring | 2.6 | 3.3 | 1.21 | 1.41 | 1-5 | 2-5 |
| Field trips, excursions | 1.8 | 1.7 | 0.68 | 0.50 | 1-3 | 1-2 |

Table &refname1 (cont.)

| | | | | | | |
|---|---|---|---|---|---|---|
| Guest speakers.....2.0 | 1.8 | 0.52 | 0.44 | 1-3 | 1-2 |
| Teacher demonstration.....3.3 | 3.2 | 0.87 | 0.67 | 2-5 | 2-4 |
| Tests or quizzes.....3.4 | 3.6 | 0.89 | 0.73 | 1-5 | 2-4 |
| Homework assignments.....4.5 | 4.1 | 0.52 | 1.27 | 4-5 | 1-5 |

HWP N = 16
UPSTEP N = 9

Table 7

Students' Perceptions of Their Science Teacher--Physical Science Grades 7, 8 and 9

| Item | Percent Responding Yes | | |
|---|---|---|---|
| | Mean | SD | Range |
| Asks questions about science | 86 | 0.12 | 53-100 |
| Likes you to ask questions | 75 | 0.18 | 31-100 |
| Lets you give your own answer | 80 | 0.11 | 56-100 |
| Really likes science | 66 | 0.15 | 46-100 |
| Makes studying science exciting | 43 | 0.22 | 8-93 |
| Knows a lot about science | 72 | 0.17 | 25-96 |
| Admits to not knowing | 72 | 0.14 | 51-100 |
| Teacher is enthusiastic | 58 | 0.23 | 8-88 |
| Encourages you to state your own opinion | 50 | 0.23 | 9-81 |
| Recognizes your right to your own opinion | 55 | 0.22 | 13-93 |
| Encourages you to think for yourself | 60 | 0.19 | 25-93 |
| Takes a personal interest in you | 24 | 0.14 | 0-55 |
| Encourages you to be creative | 42 | 0.18 | 0-66 |

N = 16

Table 8

Students' Perceptions of Their Science Teacher--Physical Science Grades 10, 11 and 12

| Item | Percentage Responding Yes | | |
|---|---|---|---|
| | Mean | SD | Range |
| Asks questions about science | .90 | 0.08 | 72-100 |
| Likes you to ask questions | .85 | 0.11 | 63-100 |
| Lets you give your own answer | .89 | 0.08 | 72-100 |
| Really likes science | .84 | 0.10 | 67-100 |
| Makes studying science exciting | .55 | 0.26 | 0-88 |
| Knows a lot about science | .80 | 0.20 | 40-100 |
| Admits to not knowing | .83 | 0.13 | 58-100 |
| Teacher is enthusiastic | .80 | 0.26 | 0-100 |
| Encourages you to state your own opinion | .57 | 0.16 | 36-88 |
| Recognizes your right to your own opinion | .70 | 0.15 | 50-100 |
| Encourages you to think for yourself | .77 | 0.12 | 62-100 |
| Takes a personal interest in you | .50 | 0.16 | 23-80 |
| Encourages you to be creative | .50 | 0.20 | 14-78 |

N = 12

Table 9

Students' Perceptions of Their Science Teacher--Biological Science Grades 7, 8 and 9

| Item | Percent Responding Yes Mean | SD | Range |
|---|---|---|---|
| Asks questions about science | 92 | 0.07 | 78-100 |
| Likes you to ask questions | 80 | 0.13 | 63-100 |
| Lets you give your own answer | 89 | 0.10 | 71-100 |
| Really likes science | 71 | 0.22 | 22-89 |
| Makes studying science exciting | 50 | 0.21 | 22-68 |
| Knows a lot about science | 89 | 0.07 | 78-100 |
| Admits to not knowing | 78 | 0.10 | 66-89 |
| Teacher is enthusiastic | 77 | 0.05 | 68-83 |
| Encourages you to state your own opinion | 63 | 0.10 | 49-78 |
| Recognizes your right to your own opinion | 67 | 0.11 | 56-89 |
| Encourages you to think for yourself | 79 | 0.10 | 59-89 |
| Takes a personal interest in you | 27 | 0.16 | 5-50 |
| encourages you to be creative | 44 | 0.22 | 16-67 |

N = 16

Table 10

Students' Perceptions of Science Teaching--Physical Science Grades 7, 8 and 9.

| Item | Percent Responding Yes Mean | SD | Range |
|---|---|---|---|
| Science class is | | | |
| fun | 54 | .23 | 0-81 |
| interesting | 58 | .22 | 17-89 |
| exciting | 39 | .18 | 6-63 |
| boring | 40 | .21 | 4-81 |
| Science class makes you feel | | | |
| uncomfortable | 15 | 0.11 | 4-50 |
| successful | 35 | 0.10 | 17-52 |
| curious | 52 | 0.11 | 31-71 |
| Choose topics or projects yourself | 13 | 0.14 | 0-54 |
| Choose the way you want to learn | 13 | 0.10 | 0-35 |
| Select the order in studying topics | 11 | 0.07 | 0-22 |
| Follow the exact order of the text | 47 | 0.20 | 13-81 |
| Worked at your own speed | 37 | 0.16 | 9-63 |
| Decided for yourself when to hand in assignments | 11 | 0.07 | 0-25 |

N = 16

Table 11

Students' Perceptions of Science Teaching--Physical Science Grades 10, 11 and 12

| Item | Percent Responding Yes Mean | SD | Range |
|---|---|---|---|
| Science class is | | | |
| fun | 65 | 0.18 | 36-89 |
| interesting | 71 | 0.22 | 50-93 |
| exciting | 47 | 0.23 | 0-83 |
| boring | 27 | 0.20 | 0-62 |
| Science class makes you feel | | | |
| uncomfortable | 12 | 0.07 | 0-22 |
| successful | 41 | 0.24 | 17-100 |
| curious | 62 | 0.18 | 31-100 |
| Choose topics or projects yourself | 8 | 0.15 | 0-54 |
| Choose the way you want to learn | 12 | 0.08 | 0-23 |
| Select the order in studying topics | 9 | 0.14 | 0-50 |
| Follow the exact order of the text | 38 | 0.19 | 5-68 |
| Worked at your own speed | 48 | 0.30 | 7-100 |
| Decided for yourself when to hand in assignments | 27 | 0.26 | 1-84 |

N = 12

Table 12

Students' Perceptions of Science Teaching--Biological Science Grades 10, 11 and 12

Biological Science, Grades 10, 11 and 12

| Item | Percent Responding Yes Mean | SD | Range |
|---|---|---|---|
| Science class is | | | |
| fun | 75 | 0.08 | 61-84 |
| interesting | 75 | 0.19 | 44-95 |
| exciting | 47 | 0.21 | 22-78 |
| boring | 24 | 0.12 | 11-44 |
| Science class makes you feel | | | |
| uncomfortable | 14 | 0.06 | 9-22 |
| successful | 34 | 0.12 | 16-48 |
| curious | 63 | 0.16 | 44-89 |
| Choose topics or projects yourself | 6 | 0.08 | 0-22 |
| Choose the way you want to learn | 20 | 0.07 | 11-33 |
| Select the order in studying topics | 7 | 0.05 | 0-16 |
| Follow the exact order of the text | 32 | 0.16 | 0-53 |
| Worked at your own speed | 32 | 0.14 | 11-47 |
| Decided for yourself when to hand in assignments | 8 | 0.04 | 0-11 |

N = 7